Energy Policy 66 (2014) 428–435

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

"Nuclear energy sounded wonderful 40 years ago": UK citizen views on CCS

Simon J. Lock*, Melanie Smallman, Maria Lee, Yvonne Rydin

University College London (UCL), Gower Street, London WC1E 6BT, United Kingdom

HIGHLIGHTS

- We present data from a series of focus groups held with lay-citizens in London in 2012.
- We found that lay-critiques of CCS were similar to those negative views put forward by environmental groups.
- Lay views on CCS were strongly framed by conceptions of nuclear power.
- This framing may present a challenge to policy-makers and industry committed to implementing CCS.

ARTICLE INFO

Article history:
Received 13 August 2013
Received in revised form
8 November 2013
Accepted 10 November 2013
Available online 9 December 2013

Keywords:
CCS
Focus groups
Nuclear power

ABSTRACT

Around the world there is increasing interest from government and industry in the potential for Carbon Capture and Storage (CCS) technologies to play a part in decarbonisation. This paper examines how people with little previous exposure to CCS technology, frame and discuss it, and how in the absence of information, ideas, notions, values and experiences shape opinion. We present data from a series of focus groups held with environmental activists, planning councillors, and adult and youth community group members in London in 2012. We found that views on CCS are shaped strongly by wider factors, particularly trade offs between different energy futures. Lay-critiques were similar to those put forward by environmental groups and were strongly framed by conceptions of nuclear power. We argue that although there is little public disquiet concerning this technology in private opinions were generally negative. This, and the use of nuclear power as a framing device, may present a challenge to policy-makers and industry committed to implementing CCS while promoting education as the main mechanism for public acceptance.

1. Introduction

In March 2012, the UK Government launched the *Carbon Capture Roadmap*. This policy, subtitled 'Supporting Deployment of Carbon Capture and Storage in the UK', leaves no doubt of the government's support for this new technology.

> "Carbon Capture and Storage (CCS) has the potential to be one of the most cost effective technologies for decarbonisation of the UK's power and industrial sectors, as well as those of economies worldwide. The Government is committed to helping make CCS a viable option for reducing emissions in the UK and in doing so to accelerate the potential for CCS to be deployed in other countries. Our vision is for widespread deployment of cost-competitive CCS "(DECC, 2012).

The UK Overarching National Policy Statement for Energy of July 2011[1] also made it clear that 'all commercial scale fossil fuelled generating stations have to be carbon capture ready' (DECC, 2011).

CCS technology involves capturing CO_2 emissions at the industrial combustion source, compressing it for transportation and transporting it (usually via pipelines) to an appropriate geological site into which it is injected for long-term storage (Gibbins and Chalmers, 2008). CCS is however controversial and there has been a protracted debate in the UK as to its desirability and effectiveness (see for example Scrase and Watson, 2009; Markusson and Shackley, 2012). Critics, such as Greenpeace, argue that it has yet to be deployed and thus shown to work on a large-scale (Greenpeace International, 2008). Others argue that it presents a moral hazard either due to risks associated with the technology or because it enables continued reliance on fossil fuels at a point where

[1] National Policy Statements must include an explanation of how the policy takes account of UK Government policy relating to the mitigation of, and adaptation to, climate change. They include the Government's objectives for the development of nationally significant infrastructure in a particular sector.

* Corresponding author. Tel.: +44 2076793763
E-mail address: simon.lock@ucl.ac.uk (S.J. Lock).

0301-4215/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.enpol.2013.11.024

investment should be shifting to fully renewable technologies (see for example Tsouris et al., 2010; Stephens and Verma, 2006). As we have seen with other technologies, such as nuclear power and GM foods, the perceptions of the public have a significant role to play in the way in which these technologies are able to be deployed. Perceptions of both the technologies themselves and the way in which they are governed, managed and controlled are important and CCS will be no different (Wüstenhagen et al., 2007). Equally, there are examples of local publics in other contexts being engaged in, and supportive of, CCS deployment (Markusson et al., 2011). It is difficult to promote technological change without some degree of public engagement and though we have seen this acknowledged with increasing political and legal commitments to public participation in decision making around these issues since the 1990s these initiatives reflect a range of approaches and motivations for involvement of the public (Stirling, 2005; Wynne, 2006). A lack of genuine engagement with public perceptions of CCS, while not necessarily leading to project failure, as was the case with the Barendrecht project in the Netherlands (Feenstra et al., 2010; Vergragt, 2009), may affect the legitimacy of the policy approach with consequent kickback impacts on governmental trust, as was arguably the case with genetically modified organisms in the UK (e.g., Wynne, 2006).

In an earlier article we explored some of the legal obligations that will provide opportunities for public participation around planning for CCS projects (Lee et al., 2013). We identified, however, tension between the perceived urgency of action on climate change, and a commitment to public participation in the development of infrastructure that forms part of that action. And in fact, whatever the legal obligations to allow for participation, a close examination of the policy background to CCS indicates that the actual space for the public to influence particular projects is very limited: enforceable legal obligations to allow for public participation around CCS are combined with limited practical opportunities to influence decisions. For example, with respect to 'moral hazard', UK national planning policy concludes that 'CO_2 emissions are not reasons to prohibit the consenting of projects which use these technologies'; more generally, 'the importance placed by the government on demonstrating CCS, and the potential deployment of this technology beyond the demonstration stage', should be taken into account in considering applications for consent of CCS projects (DECC, 2011). In this very complicated and potentially problematic context, it is interesting to begin to explore both how public views on CCS are formed, and how people view their role in the development of this particular new technology. Given this context, the aim of this paper is to explore lay-perceptions of CCS technologies. The study uses data from four focus groups conducted with different publics in London in 2012. The purpose of the study is to explore the multiple dimensions underlying social discussions of CCS projects, which may influence the deployment of the technology. It also aims to inform policy decisions on public participation with CCS technology in the future.

The paper is arranged as follows: Section 2 presents findings from previous research on both public attitudes to, and acceptance of, CCS. Section 3 provides details of our methodology—participant selection and sampling. Section 4 presents key themes that emerged from the focus group data. The final section discusses what these findings might mean in the context of further policy implementation in this area.

2. Background: attitudes to CCS

Over the past 5 years, as CCS has emerged as a significant technology, there has been considerable research that has looked at the attitudes of various stakeholder groups to CCS. Different approaches have been used to study public perceptions, with the majority being quantitative research such as surveys and questionnaires (e.g., Reiner et al., 2006; Johnsson et al., 2010; Pietzner et al., 2011; Terwel et al., 2012), and a smaller number of qualitative focus groups, interviews and workshops (e.g., Ashworth et al., 2009; Bradbury et al., 2009; Ha-Duong et al., 2009; Mabon et al., 2013). Most researchers agree that awareness of CCS amongst non-specialist groups is limited (e.g., Oltra et al., 2010; Van Alphen et al., 2007; Malone et al., 2010; Reiner et al., 2006; De Best-Waldhober et al., 2009). Given that CCS is a relatively new technology and distant to people's lives, this may not be surprising, nor relevant within a democratic context, as we go on to argue. Nevertheless, even with a brief introduction to the technology, negative reactions, particularly around risk, tend to dominate discussions. Potential leakages, impacts on ecosystems and human health, are common concerns raised (Palmgren et al., 2004; Shackley et al., 2005). In directly affected neighbourhoods, the perceptions are even more negative, with risks perceived to be higher than benefits (Huijts et al., 2007). Nor are concerns limited to risk, but extend to what we have referred to above as 'moral hazard', and to questions about who is promoting the technology and why. Higher levels of acceptance amongst the public have been shown when CCS is perceived as a bridging technology that will not reduce investments in renewable technologies, when the government is not perceived as having a special interest in a particular outcome and when the public believe they will be involved in a wider debate on climate change and CCS (Ashworth et al., 2009).

Such views differ significantly from the more optimistic views of decision-makers and experts who, as the initial quote at the beginning of this paper illustrates, tend to be more enthusiastic advocates of the technology (Huijts et al., 2007; Hansson and Bryngelsson, 2009). This difference in views is problematized in much of the literature, which argues that raising public awareness and improving public acceptance of CCS is crucial for the large scale implementation of CCS (Oltra et al., 2010; Bäckstrand et al., 2011).

The perceived need for increased public awareness is also creating conflict around the best means of accessing public opinion. Malone et al. (2010) go as far as to argue that 'the almost total lack of knowledge about CCS is a formidable barrier to conducting a valid survey of opinions'. Since the people being surveyed know little about CCS, they argue that the most surveys can do is collect 'pseudo opinions' or 'non attitudes' and therefore cannot be relied upon as an effective barometer of how the public would make decisions in specific contexts. Similarly, De Best-Waldhober et al. (2009) argue that views expressed in surveys on CCS are unstable and easily changed and therefore not a good indicator of how people will form views in a more specific context.

Public attitudes to new technologies have been the subject of research for two or more decades in Science and Technology Studies (STS) (e.g., Durant et al., 1998; Martin et al., 1992; Poortinga and Pidgeon, 2006; Scheufele and Lewenstein, 2005). These studies have produced considerable evidence to support the argument that a deficit model approach to CCS, which focuses on the need to improve the public's understanding, is problematic for two reasons.

Firstly, we know that the relationship between knowledge and attitudes is far from a straightforward and direct one—knowing more about a particular technology does not necessarily mean that someone will be more supportive or enthusiastic about it (Evans and Durant, 1995). This is supported by more recent research into CCS in particular. For instance, Upham and Roberts' (2011) pan-European focus group study, which explored citizens' attitudes to CCS as they were exposed to information about the technology, found that although this information shifted attitudes, they moved in a number of different ways. It was not necessarily the case that information produced more positive attitudes towards the

technology. In several countries, participants became more negative towards CCS after exposure to information. Likewise, a survey conducted by Pietzner et al. (2011) in Germany, Greece, Norway, the Netherlands, Romania and the United Kingdom showed that while these publics were slightly supportive of CCS, and general awareness was low, a higher level of awareness of CCS did not automatically result in higher levels of acceptance. In fact, the level of knowledge about CCS seems to have a minor influence on social acceptance (Kraeusel and Möst, 2012).

Secondly, as Riesch et al. (2013) point out, the conditions under which better-informed and more considered opinions might be formed rarely exist in reality. Given that most people will not have any personal interaction with the technology, but will be allowed to express opinions of support or otherwise within the democratic setting, how should we expect people to think about this new technology? Riesch et al. (2013) argue that a more realistic set of conditions might be those that 'enabled discussion with family or friends, influence by opinion formers through various media and arrival at more or less stable conclusions' (p. 694). Furthermore, amongst political science scholars, the matter of civil learning is an ongoing issue and there is no agreement about the knowledge requirements of democratic citizenship (Graber, 2005).

Instead of using deficit model approaches to understanding public attitudes to CCS, there is considerable STS research that suggests the need for a greater focus on understanding how publics shape their views. Crucially, the extent to which existing cultural frames of reference—interests, values, previous experience and ways of responding to and interpreting the world—shape people's evaluation of CCS. For example, a study of public attitudes to nanotechnology, another technology with a very low level of public knowledge and awareness, by Scheufele and Lewenstein (2005) drew on Popkin's work which examines decision making in the absence of information. They found that people collect only as much or as little information as they find necessary to make a decision. In the absence of any specific need to become knowledgeable about a topic, people rely upon heuristics or cognitive shortcuts to form views. This concept is also echoed in work from Social Psychology, looking at preference construction, which has found that while views or preferences are sensitive to context, they are based upon stable, revealed or inherent preferences (Kivetz et al., 2008). Furthermore, as the motivation to make a correct decision, or the opportunity to use knowledge decreases, the likelihood that these underlying attitudes will guide a choice increases (Sanbonmatsu and Fazio, 1990). We have already argued elsewhere (Lee et al., 2013) that there appears to be little scope for the public to shape policies around CCS in the UK. In light of this, and the research described above, it seems reasonable to expect that people are likely to draw strongly upon their values, predispositions and previous experiences in forming views around CCS. This paper sets out to understand this further, exploring in more detail lay responses to CCS, how it is evaluated and what is drawn upon in forming views.

As such, focus groups, though not able to provide data that is nationally representative in terms of statistical significance, provide a good opportunity to explore responses to CCS and to examine how it is evaluated and what people draw on to construct a response. It is with this last point in mind that we set out to explore attitudes towards CCS in the UK further.

3. Methodology

3.1. Procedure

The results presented here are based on four qualitative focus group discussions involving 24 interviewees, conducted in London in 2012. A focus group is a group interview in which a small number of participants (typically fewer than 20) discuss a given issue, under the guidance of a moderator who preferably assumes a retracted position (see for example Barbour and Kitzinger, 1998). Focus groups are not designed to provide data that is nationally representative. They can be useful in exploring public attitudes as they are designed to be free form in nature, to allow for participant led discussion, and particularly to allow unanticipated associations and meanings to arise spontaneously, what Petts et al. (2001) call 'shared interpretative practices'. Social attitudes can often be the result of social interactions, rather than an opinion formed in isolation and as such focus groups allow for the exploration of opinions in a social setting. Focus groups can provide access to the formation of social attitudes, framings and understandings, importantly allowing for topics to spontaneously arise which may not have arisen in a formal interview. Focus groups are susceptible to a variety of influences, particularly the interventions of the facilitator and vocal participants (Stewart et al., 2007). While this can present a problem, it can also be seen as mimicking aspects of natural or everyday conversations. In this study participants were told that they had been invited to discuss energy, but no further information was given in advance. In this way we minimised the impact of any pre-framed associations on the part of the researchers on the shape of the discussion and allowed for those issues most important to the participants to come to the fore.

The research also set out to look at the 'real world' views, as outlined above, that might be based on little information but nevertheless, within a democracy, have equal currency to those more informed opinions. Specifically, we wanted to see how people form views on CCS when confronted with limited information. We therefore did not provide any background briefing on CCS in advance and provided only a very basic description during the focus groups.[2]

3.2. Sampling

In setting up each focus group we sought to explore different perspectives, interests and levels of lay-expertise relating to energy and renewable technologies and their policy context, and to identify any potential differences. To do so, we recruited participants such that each focus group brought together people who were members of particular community groups or had similar civic roles. The different groups are detailed in Table 1.

The focus groups were all held in London and recruited from London communities. As there have been no major energy infrastructure applications within these communities, this increased the likelihood that none of the participants had direct personal experience of local energy infrastructure. The aim was to allow for a wider discussion of rights and responsibilities of citizens on local versus national priorities for low-carbon energy. We were interested in exploring different sorts of lay response to CCS given that when energy projects are developed, the 'public' will be granted formal opportunities to contribute to decision making (Lee et al., 2013). The 'public' is also not a homogeneous mass of people. Participants for the first two focus groups were recruited from members (rather than paid staff) of local environmental groups, and elected councilors who were members of local planning committees. These participants were identified as members of a particular group/organisation (environmental groups or elected councilors on planning committees) using public websites. They were contacted directly by a research assistant and invited to

[2] The basic description of CCS provided to participants was CCS technology involves capturing CO_2 emissions at the industrial combustion source, compressing it for transportation and transporting it (usually via pipelines) to an appropriate geological site into which it is injected for long-term storage.

Table 1
Focus groups.

Group no.	Participants	Participants (no. and gender)	Age range (years)	Interview date
FG1	Environmental activists	8 (6 males, 2 females)	18–65+	8th May 2012
FG2	Local councilors and members of planning committees	5 (3 males, 2 females)	36–65	10th May 2012
FG3	Local community group members	11 (1 male, 10 females)	18–65+	25th June 2012
FG4	Local youth group members	10 (9 males, 1 female)	16–18	3rd December 2012

participate. Participants for the other two focus groups, which were both held in a London community centre, were recruited by the centre on our behalf from amongst their regular user groups—one group from their adult users and another from their youth club. The centre was instructed to recruit participants without any particular expertise or interest in energy or the environment (i.e., they were not members of environmental groups or had no professional interests or stake in this area). All participants volunteered and gave their informed consent to take part in the study. All participants received a monetary incentive for their participation.

Each focus group met once and the discussions lasted 60–120 min. The focus groups were moderated by a member of the research team, with a second member being present to take notes. A semi-structured interview guide was used in all groups, whereby the facilitator used a pre-decided list of questions or prompts to put to the group, but was also encouraged to use the questions as a starting point through which to encourage a wider, free-flowing discussion. The interview guide encompassed themes such as approaches to energy policy in the UK, wind power, CCS, and views on participation around such technologies.

The focus groups were audio recorded, transcribed verbatim and analysed by two researchers using both transcripts and repeated listening to the recordings. Data was analysed using a thematic analysis approach which involves a careful reading of the data, coding generation and the identification of themes for further analysis. The themes, codes and sub-codes were agreed between both researchers (Boyatzis, 1998).

All interviews were conducted in English. All personal information has been removed from quotations to ensure participant confidentiality.

4. Results

4.1. Lay-citizens views on CCS

In keeping with previous research, we found a low level of awareness and knowledge of CCS technologies by all participants. While a number of the participants in the environmental and councillor focus groups had heard of CCS, none expressed any detailed knowledge of CCS:

> "Yeah. I've heard about it but I don't begin to understand the science behind it and I don't know if lay people can." (Group 2)

> "I'm really curious about this technology. When I started to work with my organisations I was starting to be involved in a discussion with a lot of researchers who are working in that field and I'm still reading" (Group 1)

> "I don't know enough about it…" (Group 1)

No one in the youth or community groups had heard of the technology before. Nevertheless, despite these differences, the views expressed and discussions taking place in the different focus groups bore striking resemblances to each other. On the whole, the views were negative towards CCS:

> "At the moment we don't want it, I think." (Group 2)

> "In theory it sounds a fine idea, in practice it's probably not the solution to the problem it's held up to be in the first place" (Group 2)

> "No, it's not a great solution. Because you are still polluting something else" (Group 4)

One participant seemed to accept the use of CCS, but only as a 'bridging technology':

> "But it's one of these things I think that's not a permanent solution, but it's a nice stop gap solution." (Group 1)

Another disliked it exactly because it was promising a 'techno-fix':

> "I associate it with this myth that a technology is going to come along and solve all our problems. Like, those people who say, "Oh, we'll think of something". So, we know the problems that we have, we're not going to deal with them, we'll continue along this path because a miracle will happen. I see it as one of those things, so I'm not really supportive of the whole idea." (Group 1)

Interestingly, the 'uninformed' views identified in our focus groups were not different to those elicited by other researchers who also provided information briefings to their research subjects. (see Ashworth et al., 2010 for a general list; Oltra et al., 2010). These views were also more similar to the views that previous research has attributed to environmental groups (Corry and Riesch, 2012; Huijts et al., 2007) than views attributed to industry experts (Hansson and Bryngelsson, 2009; Van Alphen et al., 2007). This raises important issues for policymakers wanting to build support for the technology—as we discuss later.

4.2. Identification of risks and uncertainties

A brief explanation of the technology[2] spontaneously generated discussion about potential risks and concerns around CCS deployment. Participants across all of the groups quickly raised and articulated many of the concerns, key risk issues and uncertainties that have been articulated by NGO groups and experts. Specifically concerns about siting and safety and the potential effects of CO_2 on wildlife and environment were common (Greenpeace International, 2008; Hansson and Bryngelsson, 2009).

Our focus group expressed concerns and doubts about siting and safety:

> "It sounds dangerous…how long can you store it?" (Group 3)

> "How safe would it be?" (Group 3)

> "Where is the carbon to be stored?" (Group 1)

> "Do we think it would be safe?" (Group 3)

Participants were also concerned about the potential effects of the CO_2 and the storage facilities affecting the environment and marine wildlife:

"What about the fish?" (Group 3)

"But how long do you have to store it before it affects something?" (Group 4)

"I mean won't there be side effects and environment problems. We're already facing these global warming things, but wouldn't that… if you put the gas underneath…" (Group 3)

In line with previous research on CCS (Upham and Roberts, 2011; Butler et al., 2013), there was considerable concern in our focus groups over identifying risks and the prevalence of uncertainty, with participants mentioning unintended consequences, such as creating earthquakes or dangerous changes to the seabed. Members of the focus groups also recognised the technological complexity of CCS and further identified the likelihood of long chains of consequences, many of them unintended; this paralleled the possible consequences of nuclear power which extended even to weapons production. This meant that, in addition to concerns about the intrinsic nature of CCS, there were concerns about implementation 'in practice', the un-tested nature of the technology and where this might lead. A major point of discussion in the focus groups related to future concerns and uncertainties around CCS:

"What are the risks of having this type of, doing this project? How is the earth going to be affected? How are we going to be affected…or what are the actual benefits, is it going to be beneficial?" (Group 3)

"As far as I recall, the engineering process has proved a lot more difficult than anticipated" (Group 2)

"If it doesn't work, would we just disconnect the fitting and just park the CO_2 in the atmosphere? It's an easy way of escaping a final solution" (Group 1)

"Basically we don't have any idea what the negative unintended consequences of that will be. It does sound like when you're using such a potentially volatile… who knows what's happen on the seabed and we have some idea that things do shift unexpectedly particularly as the globe is shifting and as global warming is affecting things." (Group 2)

"It just sounds like another problem is going to come up in the future" (Group 3)

"There may well be problems which develop, like in terms of seismic instabilities and stuff, and until it's rolled out on a large scale you won't really know whether that will be a problem or not. There might be unforeseen things" (Group 1)

There was a prolonged discussion in Group 3 about CCS being something that simply stored trouble for later, which was imbued with an overarching scepticism around the possibility of long-term storage of anything, as the extract of this conversation below exemplifies:

"F1—Whatever goes down there will come up again anyway

F2—It will come up eventually one day

F1—How are you going to hide it?" (Group 3)

4.3. CCS in the context of other energy technologies

Though many of the participants raised specific concerns about CCS as a technology in and of itself (as outlined in Sections 4.1 and 4.2 above), when discussing it as an option for reducing CO_2, it was rarely discussed in isolation from the wider context of energy demand and generation or other options:

"I think it would be much easier technically to reduce demand than it would be to go down that route." (Group 2)

"If you believe that the problem here is climate change and too much carbon in the atmosphere, then I guess that would be a feasible solution maybe, but if you believe, like I do, that the problem is more than that, it's the whole cycle, how we develop, how we define growth or use our limited resources, possible over population then that is a small drop in the bucket of the fixes that we need". (Group 1)

CCS was also discussed very much in terms of its impact on other energy technologies. In particular, participants constructed a tradeoff between CCS and renewables, pointing out that CCS would be problematic if its development was at the expense of investment in renewables:

"…we need to compare will this be better than having wind turbines around?" (Group 3)

Several participants touched on what experts call the 'moral hazard' of CCS deployment. Concerns here were focused on the technology allowing continued use of oil and gas, and potentially delaying action on other low carbon energy options:

"…if it helps to reduce the environmental impact system, it's definitely worth pursuing, but not at the expense of developing renewable and energy efficiency" (Group 1)

"I'm sceptical because that's the way of going on with your approach of use of electricity or energy or whatever and trying to postpone the change" (Group 1)

"Isn't it just an excuse to keep using coal and oil that is running out anyway?" (Group 3).

"I think it supports continuing with big building, used to justify building new big coal power plants or gas turbines or whatever then it's carrying on. We can carry on business as usual and "look we're dealing with climate change because we're working with carbon capture and storage." (Group 1)

4.4. Nuclear power as a framing device

Participants in all but the youth group (Group 4) drew parallels to nuclear power seemingly using nuclear as a dominant frame through which to judge this new technology. The comparison was not a favourable one, with all views on nuclear power being negative ones. These comparisons were made very early on in the discussion and spontaneously, without reference to any external prompts. This framing appeared to shape their views in a number of ways, drawing on more obvious comparisons between CCS and nuclear such as the long-term storage difficulties of both technologies, to more abstract ones comparing the hype surrounding both as well as each being perceived as a technological and 'unnatural' fix to problems of energy and climate:

"F1—That sounds potentially a little bit risky to me.

M1—In the way that nuclear energy sounded wonderful 40 years ago.

F1—Yeah, we'll just put it under the sea". (Group 2).

"That reminds me a lot of the way we discuss all the time about nuclear power. It's not just a building or plant station but there are a lot of extra costs that you have to consider." (Group 1)

"Didn't they try [storing waste in rocks] with nuclear? it would be much worse with carbon dioxide because it would kill the fish" (Group 3)

"I think in a way it again parallels with nuclear because if the Government of whoever says 'oh we can build a new coal or gas power station because we will have CCS and deal with the CO_2.' And it's like with nuclear they say we can build a nuclear power station because we will have worked out what to do with the waste." (Group 1)

Where previous studies have noted that nuclear power can come up in general conversation about CCS, it is usually as one among many comparisons made (Upham and Roberts, 2011). One previous study (Riesch et al., 2013) found online participants drawing heavily on the earthquake and subsequent tsunami in Japan leading to the Fukushima nuclear power plant crisis—to critique and question the relative safety of CCS as a similarly conceived large-scale energy infrastructure. Here they argued that the immediacy of real-world events beyond the information provided in a focus group setting had affected how people frame and discuss CCS. As Riesch et al. argue, the events 'provided a 'ready-frame' with which participants could articulate fears about unknown or predictable risks: the respondents' *social representation* of the unfamiliar technology of CCS was conceptually *anchored* to the more well known energy technology (Riesch et al., 2013). Our results suggest that the framing of nuclear power may go beyond simply using a 'ready frame' to something much deeper and less temporally specific—for instance, our focus groups were held 18 months after the Fukushima crisis, and nothing specific about these events was mentioned in our groups. Indeed any reference to real world events tended to be much more historic—referring to incidents that happened during the testing of nuclear power during the 1960s, or nuclear accidents of the 1970s and 1980s:

"If you remember they did that with the enriched uranium … from the nuclear power plant and they buried them … in the 60s and the early 70s, not only in this country but most of the Western countries have done that …" (Group 3)

The dominant negative framing of CCS by a stigmatized technology such as nuclear power contrasts with a positive framing of some other options. Here wind and solar power, alongside demand management were framed as positive pathways. They were described repeatedly as 'sensible' thus making an appeal to everyday understanding that may not easily be challenged by the provision of more information. Wind and solar power were also seen as 'cheaper' and demand management as 'easier', a contrast with the perceived costs and technological complexity of CCS. Indeed we sensed an incredulity amongst the participants that complex technologies such as nuclear or CCS could possibly work out cheaper than wind or solar energy.

"Well, wind is there and we're not going to run out of it. Nuclear power depends on a limited uranium stocks, it's very expensive to produce nuclear power stations, they produce enormous amounts of waste that will remain dangerous for thousands and thousands of years, and none of those things can be said about wind power." (Group 1)

"Wind and solar would be much more sensible and cheaper. We need cleaner and cheaper ways to produce electricity" (Group 3)

Interestingly, CCS was also described as 'foreign' and 'unnatural' while wind and solar were deemed 'familiar' and 'natural'.

"… comparisons can be drawn between nuclear power and Carbon Capture and Storage because of its technological basis, it's kind of complicated, it's foreign to us. Wind, solar on the other hand [are] both very simple … generally these are the things we're familiar with because it's natural, so for those reasons the wind power is something that most people would be comfortable with." (Group 1)

"Wind is natural, the wind turbine not so much. But … I don't see it as being unnatural at all, it is just our technological way of harnessing the natural and it's working." (Group 1)

Other studies have found similar comparisons with other technologies (solar, wind) with CCS being perceived as more distant, risky and unfamiliar technology (Oltra et al., 2010). This is a powerful opposition in which alternatives to CCS can be variously considered 'ours', domestic, native, familiar and/or authentic depending on how the word 'foreign' is read. This contrast will be a difficult one to shift as it emphasises features that are intrinsic to the technologies and their deployment, rather than unfortunate consequences.

4.5. Trust in government and the use of diversionary tactics

Some of our participants discussed CCS as something 'being done to us'. There was a distinct sense of feeling 'out of the loop', or a loss of agency, in terms of having a say or input, from our participants and of a decision to deploy CCS being taken elsewhere without any input from them, as the discussion below exemplifies:

"F1—I say you think of all of this and before you know it it's already been done.

F2—Yeah before you know it its already been done to you, you know? And you can't do nothing, You're just eating all these fish and you're going to the sea to bathe and suddenly you have all these problems and allergies, that you don't even know where they come from.

F1—And we haven't been given the opportunity to give an opinion to say yes or no or whatever. To me personally I think its something that we need to be informed properly how will it work." (Group 3)

Previous research has also emphasised the lack of trust that the public hold in relation to government where technologies are associated with environmental risks and uncertainties (Pidgeon et al., 2003; Frewer, 1999; Wynne, 2006). The case of CCS is no different. What the focus groups did reveal though is the sense that the government were being under-hand and using diversionary tactics. Participants (as outlined in Section 4.3) saw CCS as being used to justify new coal power plants and cover for the continued use of fossil fuels. A reliance on CCS was 'an excuse' and 'an easy way of escaping'. Not only was the government postponing change —change that was seen as necessary and perhaps even inevitable— but they were hiding a mistake (reliance on fossil fuels) that they had already made. There was a sense that such diversionary tactics would not work; the mistake could not be hidden forever and 'it will come up eventually one day'.

"It sounds to me that once they made the mistake and now they are trying to hide it under the earth? It sounds to me like that. Whatever the mistake they made with the energy and building up their carbon dioxide and now they are trying to hide it. And they're telling us that "no that's a nice thing it's a very nice thing"…" (Group 3)

Finally it was clear that this lack of trust in government was connected to the sense that the general public were powerless in this policy context, which reinforces our earlier concerns (Lee et al., 2013) that the limited scope for publics to influence decisions in this area may further weaken trust. People felt that 'its already been done to you… you can't do nothing'; there was no option to say 'yes' or 'no'.

5. Conclusions and policy implications

In this paper, we have looked at the outputs of four focus groups where members of the public, not directly involved in energy policy or in a specific locally situated context, discussed energy futures. From these discussions, we have identified a number of factors that we believe shed light into how CCS is evaluated and what people draw on to construct a response.

Firstly, we found that people's views on CCS are shaped and framed by wider factors. While the technology raises specific concerns and aspirations, these are rarely in isolation from a bigger picture. Participants quickly started discussing trade-offs between CCS and other renewable technologies and were concerned that CCS might be developed at the expense of other renewable technologies. As such, people's support or otherwise for CCS was strongly dependent upon concerns about overall energy trajectories and possible lock-in to one scenario over another. Our research suggest that if the public are to be given the opportunity to engage on CCS technology this should be part of a much wider conversation about energy supply and demand as a whole. Recent work by UKERC has provided further evidence which demonstrates the value of this approach (Butler et al., 2013; Parkhill et al., 2013).

Secondly, we found that in considering CCS within this wider 'energy futures' context, many constructed a mental dichotomy that splits technologies between 'good', 'natural' and commonsense technologies (exemplified by wind turbines) and 'bad', 'unnatural' and industrialised technologies (exemplified by nuclear power). CCS was put into the less positive 'nuclear' category within this dichotomy.

Previous research has shown that people respond to unfamiliar things or technologies by drawing on existing ideas, notions, values and experiences. The literature on CCS and other technologies such as nanotechnology and GM has shown that people draw very strongly on their previous experience of other technologies to create historic analogies (Scheufele and Lewenstein, 2005; Currall et al., 2006; Upham and Roberts, 2011). Here we found that nuclear power was not simply a signpost to possible views, but was a dominant frame drawn on to make sense of CCS technology and to articulate their concerns and reservations. This frame did not appear to be related to recent nuclear incidents and Fukashima, for instance, was not mentioned.

Significantly, the group made up of 16–18 year olds did not seem to evoke the nuclear power frame. This suggests that such an association is generational, possibly based on first-hand memories of events/public discourses relating to nuclear power. Given that the UK has not had any new nuclear power developments, nor high-profile debate on the matter for three or more decades, the young people would not have been exposed to public discourse or events relating to nuclear power. Their associations with nuclear were from popular culture (*The Simpsons*) and related to nuclear weapons. This does however raise interesting questions about the possible impact of current plans for new nuclear build in the UK. Even without exposure to nuclear debates, most of the participants in our youth group expressed negative views toward nuclear power. It is possible that the new developments will simply provide harder evidence to justify these negative views.

There are clear technical parallels to be drawn between nuclear power and CCS—for example, long term storage of a 'waste product' or storage siting issues. Furthermore, Reiner and Nuttall (2011) have speculated that the environmental movement's history of opposition towards nuclear power may precipitate similar protest towards CCS. They suggest, however, that this would be as part of 'a continuous tradition of countercultural protest' (p. 307), rather than being solely a result of people's specific engagement with CCS and its technical parallels with nuclear. We suggest here that nuclear power was operating as what the social psychology literature would term an *anchor* or *trope* for interpreting CCS as a technology (Farr, 1993; Wagner and Kronberger, 2001). Further, the use of nuclear power as a framing device in our focus groups appeared to be operating in a more historic, embedded and symbolic manner than other instances where similar parallels have been noted (Riesch et al., 2013).

Our findings also challenge current arguments from industry and much of the acceptance research literature that the public simply needs more information or education on CCS, before real or substantial views can be formed (Ashworth et al., 2010; Science Buisiness Symposium, 2012). As we have argued at the beginning of the paper, there is no minimal knowledge requirement within a democracy. If CCS is rolled out, this will be against a backdrop of various levels of engagement and knowledge of the technology. People will express views regardless of how expert or otherwise they are in the technology. Our research however has shown that despite very minimal levels of knowledge, members of the public are able to form coherent views about CCS and to articulate clear justifications for these views. The concerns and questions expressed have strong resemblances to the key concerns and questions being considered by 'experts' in CCS—concerns about environmental impact of accidental leaks, risk of unintended consequences, the untested nature of the technology and the long term trajectory it sets us upon, for instance. These are substantial and justifiable concerns rather than fictional or imagined issues.

We found that there was little difference in the views of those lay-participants who we found already knew a little about CCS (environmental groups and local councillors) and those who had known nothing in advance. Significantly, the views expressed by both these groups were more similar to each other and to those of environmental groups objecting to CCS than to the views of the CCS industry and the UK Government (Greenpeace International, 2008; Huijts et al., 2007; Hansson and Bryngelsson, 2009). This presents a further challenge to those arguing that the gap between public and expert views of CCS demonstrates the need for simply more information. Instead of the public having unformed views waiting to be made positive, we argue that our research demonstrates that many members of the public have latently negative views waiting to be expressed. Evidence from other technologies (Gaskell et al., 1998; Martin et al., 1992) suggests that in other similar situations, more information has merely acted to polarise and reinforce existing views. The relationship between knowledge and attitudes to new technologies is complex. Furthermore, without a 'need' to obtain more information, for example by feeling that one's say will feed into policy, there is little reason to believe that information giving will have any effect. People will likely draw strongly upon their values, predispositions and previous experiences in forming views around CCS.

Last, this research raises a wider question of the involvement of the public in discussions not simply about CCS, but about our energy future. If the public, as is suggested here and elsewhere, do not feel that they have any say in high-level decisions about energy futures and are only consulted at a local level to manage the impact of decisions already made for them with respect to one technology, this starts any public participation process off on the wrong foot. Furthermore, we would challenge proposals for a communication approach that prioritises educating an ignorant public on the specifics of one technology. Instead, our research suggests that a broader conversation that acknowledges the wider issues around energy use might precipitate more trust and legitimate decisions—although not necessarily agreement.

Acknowledgements

Thanks are due to all of our focus group participants. Thanks also to Chiara Armeni, Ana Padilla and Sarah Chaytor, all members

of our research group at UCL, for their input and advice, and to our two anonymous peer reviewers for their substantive and helpful feedback.

References

Ashworth, P., et al., 2010. From research to action: now we have to move on CCS communication. Int. J. Greenh. Gas Control 4 (2), 426–433.

Ashworth, P., Pisarski, A., Thambimuthu, K., 2009. Public acceptance of carbon dioxide capture and storage in a proposed demonstration area. Proc. Inst. Mech. Eng. A: J. Power Energy 223 (3), 299–304.

Bäckstrand, K., Meadowcroft, J., Oppenheimer, M., 2011. The politics and policy of carbon capture and storage: framing an emergent technology. Glob. Environ. Change 21 (2), 275–281.

Barbour, R., Kitzinger, J., 1998. Developing Focus Group Research: Politics, Theory and Practice. SAGE, London.

Boyatzis, R.E., 1998. Transforming Qualitative Information: Thematic Analysis and Code Development. SAGE.

Bradbury, J., et al., 2009. The role of social factors in shaping public perceptions of CCS: results of multi-state focus group interviews in the US. Energy Procedia 1 (1), 4665–4672.

Butler, C., Parkhill, K.A., Pidgeon, N., 2013. Deliberating Energy System Transitions in the UK Transitions in the UK, UKERC, London.

Corry, O., Riesch, H., 2012. Beyond "For or Against" environmental NGO-evaluations of CCS as a climate change solution. In: Markusson, N., Shackley, S., Evar, B. (Eds.), The Social Dynamics of Carbon Capture and Storage. Routledge, Oxford, pp. 116–133.

Currall, S.C., et al., 2006. What drives public acceptance of nanotechnology? Nat. Nanotechnol. 1 (3), 153–155.

De Best-Waldhober, M., Daamen, D., Faaij, A., 2009. Informed and uninformed public opinions on CO_2 capture and storage technologies in the Netherlands. Int. J. Greenh. Gas Control 3 (3), 322–332.

DECC, 2011. Overarching National Policy Statement for Energy (EN-1).

DECC, 2012. CCS Roadmap: Supporting deployment of Carbon Capture and Storage in the UK.

Durant, J., Gaskell, G., Bauer, M., 1998. Biotechnology in the Public Sphere: A European Sourcebook. Science Museum, London.

Evans, G., Durant, J., 1995. The relationship between knowledge and attitudes in the public understanding of science in Britain. Public Underst. Sci. 4 (1), 57–74.

Farr, R.M., 1993. Commonsense, science and social representations. Public Underst. Sci. 2 (3), 189–204.

Feenstra, C.F.J., Mikunda, T., Brunsting, S., 2010. What happened in Barendrecht? Case study on the planned onshore carbon dioxide storage in Barendrecht, the Netherlands. Available from: ⟨http://www.csiro.au/Outcomes/Energy/Energy-from-coal/Barendrecht-case-study.aspx⟩.

Frewer, L., 1999. Risk perception, social trust, and public participation in strategic decision making: implications for emerging technologies. AMBIO 28 (6), 569–574.

Gaskell, G., Bauer, M., Durant, J., 1998. Public perceptions of biotechnology in 1996: Eurobarometer 46.1. In: Gaskell, G., Bauer, M., Durant, J. (Eds.), Biotechnology in the Public Sphere: A European Sourcebook. Science Museum, London, pp. 189–214.

Gibbins, J., Chalmers, H., 2008. Carbon capture and storage. Energy Policy 36 (12), 4317–4322.

Graber, D.A., 2005. Political communication faces the 21st century. J. Commun. 55 (3), 479–507.

Greenpeace International, 2008. False Hope, Why Carbon Capture and Storage Won't Save the Climate.

Ha-Duong, M., Nadaï, A., Campos, A.S., 2009. A survey on the public perception of CCS in France. Int. J. Greenh. Gas Control 3 (5), 633–640.

Hansson, A., Bryngelsson, M., 2009. Expert opinions on carbon dioxide capture and storage—a framing of uncertainties and possibilities. Energy Policy 37 (6), 2273–2282.

Huijts, N.M.A., Midden, C.J.H., Meijnders, A.L., 2007. Social acceptance of carbon dioxide storage. Energy Policy 35 (5), 2780–2789.

Johnsson, F., et al., 2010. Stakeholder attitudes on carbon capture and storage—an international comparison. Int. J. Greenh. Gas Control 4 (2), 410–418.

Kivetz, R., Netzer, O., Schrift, R., 2008. The synthesis of preference: bridging behavioral decision research and marketing science. J. Consum. Psychol. 18 (3), 179–186.

Kraeusel, J., Möst, D., 2012. Carbon Capture and Storage on its way to large-scale deployment: Social acceptance and willingness to pay in Germany. Energy Policy 49, 642–651.

Lee, M., et al., 2013. Public participation and climate change infrastructure. J. Environ. Law 25 (1), 33–62.

Mabon, L., et al., 2013. "Tell me what you think about the geological storage of carbon dioxide ": towards a fuller understanding of public perceptions of CCS. Energy Procedia 00, 1–10.

Malone, E.L., Dooley, J.J., Bradbury, J.A., 2010. Moving from misinformation derived from public attitude surveys on carbon dioxide capture and storage towards realistic stakeholder involvement. Int. J. Greenh. Gas Control 4 (2), 419–425.

Markusson, N., Ishii, A., Stephens, J.C., 2011. The social and political complexities of learning in carbon capture and storage demonstration projects. Glob. Environ. Change 21 (2), 293–302.

Markusson, N., Shackley, S., 2012. Perceptions and representations. In: Markusson, N., Shackley, S., Evar, B. (Eds.), The Social Dynamics of Carbon Capture and Storage: Understanding CCS Representations, Governance and Innovation. Routledge, Oxford, pp. 58–69.

Martin, S., Tait, J., Durant, J., 1992. Attitudes of Selected Public Groups in the UK to Biotechnology, pp. 28–41.

Oltra, C., et al., 2010. Lay perceptions of carbon capture and storage technology. Int. J. Greenh. Gas Control 4 (4), 698–706.

Palmgren, C.R., et al., 2004. Initial public perceptions of deep geological and oceanic disposal of carbon dioxide. Environ. Sci. Technol. 38 (24), 6441–6450.

Parkhill, K., Pidgeon, N., Demski, C., Butler, C., & Spence, A. (2013). Transforming the UK Energy System: Public Values, Attitudes and Acceptability - Synthesis Report. UKERC, London.

Petts, J., Horlick-Jones, T., Murdock, G., 2001. Social Amplification of Risk: The Media and the Public. HSE Books, Sudbury.

Pidgeon, N.F., Kasperson, R., Slovic, P., 2003. The Social Amplification of Risk. Cambridge University Press, Cambridge.

Pietzner, K., et al., 2011. Public awareness and perceptions of carbon dioxide capture and storage (CCS): insights from surveys administered to representative samples in six European countries. Energy Procedia 4, 6300–6306.

Poortinga, W., Pidgeon, N.F., 2006. Exploring the structure of attitudes toward genetically modified food. Risk Anal.: Off. Publ. Soc. Risk Anal. 26 (6), 1707–1719.

Reiner, D. et al., 2006. An international comparison of public attitudes towards carbon capture and storage technologies. In: Proceedings of the 8th International Conference on Greenhouse Gas Control Technologies (GHGT-8). Trondheim, Norway, June 18–22.

Reiner, David M. et al., 2011. Public acceptance of geological disposal of carbon dioxide and radioactive waste: similarities and differences. Geological Disposal of Carbon Dioxide and Radioactive Waste: A Comparative Assessment. Springer Netherlands, 295–315.

Riesch, H., et al., 2013. Internet-based public debate of CCS: lessons from online focus groups in Poland and Spain. Energy Policy 56, 693–702.

Sanbonmatsu, D.M., Fazio, R.H., 1990. The role of attitudes in memory-based decision making. J. Personal. Soc. Psychol. 59 (4), 614–622.

Scheufele, D.a., Lewenstein, B.V., 2005. The public and nanotechnology: how citizens make sense of emerging technologies. J. Nanopart. Res. 7 (6), 659–667.

Science Buisiness Symposium, 2012. Breaking the Deadlock: Getting Carbon Capture and Storage to Market.

Scrase, J.I., Watson, J., 2009. Strategies for the deployment of CCS technologies in the UK: a critical review. Energy Procedia 1 (1), 4535–4542.

Shackley, S., McLachlan, C., Gough, C., 2005. The public perception of carbon dioxide capture and storage in the UK: results from focus groups and a survey. Clim. Policy 4 (4), 377–398.

Stephens, J., Verma, P., 2006. The role of environmental advocacy groups in the advancement of carbon capture and storage (CCS). In: Proceedings of the Fifth Annual Conference on Carbon Capture & Sequestration. May 2006.

Stewart, D.W., Shamdasani, P.N., Rook, D.W., 2007. Focus Groups: Theory and Practice. Sage Publications, Thousand Oaks CA.

Stirling, A., 2005. Opening up or closing down: analysis, participation and power in the social appraisal of technology. In: Leach, M., Scoones, I., Wynne, B. (Eds.), Science, Citizenship and Globalisation. Zed, London, pp. 218–231.

Terwel, B.W., ter Mors, E., Daamen, D.D.L., 2012. It's not only about safety: beliefs and attitudes of 811 local residents regarding a CCS project in Barendrecht. Int. J. Greenh. Gas Control 9, 41–51.

Tsouris, C., Aaron, D.S., Williams, K.A., 2010. Is carbon capture and storage really needed? Environ. Sci. Technol. 44 (11), 4042–4045.

Upham, P., Roberts, T., 2011. Public perceptions of CCS: emergent themes in pan-European focus groups and implications for communications. Int. J. Greenh. Gas Control 5 (5), 1359–1367.

Van Alphen, K., et al., 2007. Societal acceptance of carbon capture and storage technologies. Energy Policy 35 (8), 4368–4380.

Vergragt, P., 2009. CCS in the Netherlands: glass half empty or half full. In: Meadowcraft, J., Langhelle, O. (Eds.), Catching the Carbon: The Politics and Policy of Carbon Capture and Storage. Edward Elgar, Cheltenham.

Wagner, W., Kronberger, N., 2001. Killer Tomatoes! Collective symbolic coping with biotechnology. In: Deaux, K., Philogene, G. (Eds.), Representations of the Social —Bridging Theoretical Traditions. Blackwell, Oxford.

Wüstenhagen, R., Wolsink, M., Bürer, M.J., 2007. Social acceptance of renewable energy innovation: an introduction to the concept. Energy Policy 35 (5), 2683–2691.

Wynne, B., 2006. Public engagement as a means of restoring public trust in science —hitting the notes, but missing the music? Community Genet. 9, 211–220.